RISK ANALYSIS AND LONG-TERM SURVIVAL IN PATIENTS UNDERGOING EXTENDED RESECTION OF LOCALLY ADVANCED LUNG CANCER

Although locally advanced lung cancer frequently necessitates extended resections to preserve a chance for cure, a higher morbidity is associated with extended resections. It is not known whether the increased morbidity is of relevance for the long-term outcome. It also remains unclear whether exclusion of certain patients according to their risk factors can diminish mortality in these patients. This study therefore investigated whether certain risk factors predispose patients undergoing extended pulmonary resections to increased morbidity or mortality. It also assessed the long-term survival. The cases of 126 consecutive patients with locally advanced lung cancer (stage T3 or T4) were prospectively documented. Seventy-five percent of the patients required an extended resection and 25% a nonextended resection. Extended resections were associated with a significantly increased overall morbidity ($p < 0.002$). However, mortality, severe complications, or multiple complications were not significantly increased after extended resections. No risk factor predisposed to an increased mortality. Risk factors that were associated with particular postoperative complications were pathologic ergonometry ($p < 0.002$), a positive cardiac score ($p < 0.003$), coronary artery disease ($p = 0.021$), and an increased pulmonary risk score ($p < 0.05$). Overall 3-year survival was 31%. Patients undergoing extended resections for stage T3 or T4 tumors with no residual tumor (70% of the patients) showed a 3-year survival of 33%. We conclude that postoperative mortality cannot be reduced by excluding patients on the basis of particular risk factors from operations that require extended resections. If a patient is considered to be eligible to undergo pulmonary resection, he or she can be considered to be eligible to undergo extended pulmonary resection. Because prognosis is dismal in nonresected locally advanced lung cancer, we recommend an aggressive surgical approach.
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Only 25% to 30% of all patients with carcinoma of the lung are first seen with surgically resectable tumors.[1,2] In nonadvanced non-small-cell lung carcinoma surgical removal of the tumor offers a chance for cure with 5-year survivals of 50% to 70% for stage I and 30% to 40% for stage II lesions.[3,4] However, the heterogeneous stage III disease with a 5-year survival rate of 10% deserves a differentiated analysis and approach.

Whereas clinical N3 disease will interfere with any curative intent, no established therapeutic approach can be offered to patients with clinical N2, T3, or T4 disease. This is especially true for locally advanced lung cancers. In these patients, frequently the concern about postoperative morbidity and mortality conflicts with the intent to potentially provide cure. Treatment therefore ranges from palliative treatment modalities such as radiation therapy to aggressive operation.

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Table Ia. *Staging and clinical data*

	Extended resections	*Nonextended resections*
Age in years (mean/range)	59 (29-77)	57 (45-79)
Male:female	7:1	15:1
R0 resections	66 (70%)	29 (91%)
R1 resections	16 (17%)	2 (6%)
R2 resections	12 (13%)	1 (3%)
Stage T3 disease	64*	22†
Stage T4 disease	30	10
Stage T3/T4 disease	2.1:1	2.2:1
Pathologic N0 disease	27 (29%)	7 (22%)
Pathologic N1 disease	28 (30%)	16 (50%)
Pathologic N2 disease	37 (39%)	9 (28%)
Pathologic N3 disease	2 (2%)	0 (0%)

*Tumors in five patients intraoperatively considered as stage T3 were staged as T2 tumors pathologically.

†Tumors in four patients intraoperatively considered as stage T3 were staged as T2 tumors pathologically.

Because the need for an extended resection can usually be anticipated,[5] the decision to operate on these patients will be strongly influenced by the assessment of general risk factors. The aim of this study was to determine the survival after extended pulmonary resections and whether a risk factor analysis could provide guidelines to reduce the mortality and high morbidity commonly associated with extended pulmonary resections.

Material and methods

Between January 1, 1987, and December 31, 1990, 325 consecutive patients with carcinoma of the lung underwent resection and their cases were prospectively documented. A total of 126 patients (39%) were first seen with locally advanced lung cancer classified as stage T3 or T4 tumor during operation. These patients are the subject of this study.

Extended resections were defined as multivisceral resections including adjacent structures. They were done if tumor adherence to the neighboring structures was found at operation. The adjacent structures included thoracic wall, pericardium, pulmonary artery, diaphragm, trachea, esophagus, atrium, and superior vena cava.

The mean age of patients was 59 years, with a range of 29 to 77 years. Twenty patients (16%) were older than 70 years. There were 111 male and 15 female patients. The median follow-up was 37.8 months and ranged from 19 to 70 months, with 29 patients lost to follow-up. The patients were censored once lost to follow-up according to the Kaplan-Meier method. In 64 cases the cancer was located on the right side and in 62 cases it was on the left side. In 94 (75%) of 126 patients with stage T3 or T4 disease an extended resection was done. In the remaining 32 patients (25%) a nonextended resection was done (Table I). The patients were well matched according to age, sex, and pathologic features of the tumor (Table I). The histologic typing of tumors is shown in Table II. R0 resections are resections without residual tumor, R1 indicates microscopic residual tumor, and R2 indicates gross residual tumor. Table III shows types of operation done and the involved organs in patients with extended resections. Extended resections were achieved by resection of 119 adjacent organs or structures in the 94 patients undergoing extended resections. In 72 patients only one organ or structure was resected, in 19 patients two organs (in most cases the thoracic wall and pericardium) were resected, and in 3 patients more than two organs or structures were resected. In 78% of extended resections tumor invasion into the adjacent organ was confirmed by histologic examination. In the group of nonextended resections the overwhelming majority of operations were pneumonectomies. This was a result of either a distance of the tumor to the carina of less than 2 cm or extensive adherence of the tumor to the pulmonary artery. In four cases of nonextended resection a lobectomy was combined with a bronchoplastic procedure or a bronchial sleeve resection. These were not classified as extended resections because they were not multivisceral resections.

All patients in whom the pathohistologic examination revealed a T3, T4, or N2 stage underwent postoperative percutaneous radiation therapy of the mediastinum or the tumor bed with a radiation dose of 50 Gy. This protocol has been approved by the Tumorzentrum Munich.

The preoperative work-up consisted of routine chest radiographs, an electrocardiogram, bronchoscopy with perbronchial or intraluminal biopsies, and computed tomographic scanning of the thorax and abdomen, as well as abdominal ultrasonography and a bone scan. For assessment of risk factors all patients had preoperative pulmonary function studies, including body plethysmography and preoperative measurement of resting arterial blood

Table Ib. *Survival according to T and N status after extended resection**

Pathologic disease	*n (%)*	*Three-year survival (%)*
T3 N0	15 (31)	33
T3 N1	19 (40)	24
T3 N2	14 (29)	14.2
T4 N0	6 (24)	0
T4 N1	7 (28)	53
T4 N2	12 (48)	16.6

*Excluded are two patients with N2 pathologic status and five patients with T2 pathologic status, seven patients who died within 30 days after operation, and seven patients without follow-up data.

Table II. *Histopathologic typing of resected bronchial carcinomas*

	Extended resections	*Nonextended resections*
Squamous cell carcinoma	55	21
Adenocarcinoma	26	4
Adenosquamous carcinoma	2	4
Large-cell carcinoma	4	1
Small-cell carcinoma	2*	0
Others	5	2

*Preoperative work-up had suggested non-small-cell lung cancer.

Table III. *Types of operation and organs resected during extended resections*

	Extended	*Nonextended*	*Total*
Pulmonary resections			
Lobectomy	46	4	50
Bilobectomy	7	0	7
Pneumonectomy	41	28	67
Total	94	32	126
Resection extended by resection of			
Thoracic wall	46		
Pericardium	39		
Pulmonary artery	15		
Diaphragm	5		
Trachea/carina	7		
Esophagus	4		
Atrium	1		
Superior vena cava/ azygos vein	2		
Total	119		

gas values and blood gas values under stress. To assess cardiac reserve bicycle ergonometry was done. Ventilation/perfusion scanning and regional studies were reserved for patients with forced expiratory volume in 1 second (FEV_1) less than 1.5 L.

All patients received preoperative training in chest physiotherapy. The use of chest drainages and the methods of coughing and deep breathing were demonstrated. The significance of early ambulation for rapid convalescence and for avoidance of cardiovascular and pulmonary complications was explained.

Risk factors

Assessment of cardiac risks. Fifteen percent of the patients had a recorded history of cardiac disease. This included a history of myocardial infarction, electrocardiographic (ECG) evidence of an infarct, or history of angina, arrhythmia, congestive heart failure, or valvular disease. Pathologic ECG alterations during bicycle ergonometry were found in 20% of the patients. Arterial hypertension was observed in 19% of the patients (defined as diastolic pressure >90 mm Hg).

A patient was considered to be at minor cardiac risk if he or she was able to perform bicycle ergonometry at 80 watts for 3 minutes. If the patient was not able to perform at this level or showed pathologic ECG alterations, he or she was considered to be at high cardiac risk.

A cardiac score was designed by adding cardiac history (yes 1, no 0), history of coronary artery disease (yes 1, no 0), congestive heart failure (yes 1, no 0), history of myocardial infarction (yes 1, no 0), arrhythmia (yes 1, no 0), pathologic ECG changes on ergonometry (yes 2, no 0), and performance on ergonometry of less than 3 minutes at 80 watts (yes 1, no 0). A score of 0 or 1 was considered to represent a low cardiac risk.

Patients were not considered candidates for operation if they were not able to perform bicycle ergonometry at 60 watts for 3 minutes.

Assessment of pulmonary risks. Chronic obstructive pulmonary disease as assessed by pulmonary function tests

Table IV. *Functional parameters used to determine pulmonary risk score II*

	FEV_1 (L)	*VC (%)*	*Resting arterial Po_2 (mm Hg)*	*Increase of Po_2 under stress (%)*
Score				
1	>2	>80	>70	>+10
2	1.5-2	60-80	60-70	±10
3	<1.5	<60	<60	>−10

was present in 64% of the patients. Nine percent of the patients had concomitant pneumonia in all cases classified as retention pneumonia because of a central location of the tumor. Thirteen percent of the patients had the roentgenonologic and laboratory findings of chronic lung emphysema.

To assess the pulmonary risk two scores were designed. Pulmonary risk score I was constructed by adding emphysema (yes 1, no 0), pneumonia (yes 1, no 0), chronic obstructive pulmonary disease (COPD) (yes 1, no 0), FEV_1 less than 1.5 L (yes 1, no 0), vital capacity (VC) less than 80% (yes 1, no 0), and increase of oxygen tension (Po_2) under 3-minute, 80-watt stress (no 1, yes 0). A score of 0 to 3 was considered as low risk, a score of 4 or 5 as intermediate, and a score higher than 5 as high risk. The diagnosis of COPD was established if FEV_1 was decreased, the ratio of FEV_1:forced VC was less than 75%, and the alveolar-arterial oxygen gradient was increased. Emphysema was defined as COPD with increased anteroposterior chest diameter on the chest radiograph in the absence of predominant symptoms of chronic bronchitis.

Whereas pulmonary risk score I included anamnestic and functional parameters, pulmonary risk score II was constructed by adding the scores shown in Table IV on the basis of functional parameters only. In this scoring system a score of 4 or 5 was considered to represent low risk. Intermediate risk was represented by a score of 6 or 7 and high risk by a score from 8 to 12. A patient was not considered a candidate for operation that sacrificed functional lung tissue if the FEV_1 was less than 1 L.

Other risk factors. Fifteen percent of the patients had diabetes and 2.5% of them were insulin dependent. Ten percent of the patients showed severe obesity with a body weight of more than 50% greater than the ideal body weight. In 8% of the patients renal insufficiency was observed (defined as serum creatinine value ≥1.5 mg/dl).

Statistical analysis. Survival (crude cumulative survival) was calculated according to the Kaplan-Meier method excluding the 30-day mortality and analyzed by the log-rank test.[6] Statistical analysis of parameters was done by the χ^2 test with Yates' correction and one-way analysis of variance. Normal distribution was evaluated by the normal probability plot. The level of significance was set at $p = 0.05$.

Results

Postoperative mortality. The 30-day mortality rate in extended resections was 7.5% (7 patients). Two patients died of postoperative sepsis with mul-

Table V. *Postoperative complications*

	Extended resections (n = 94)		*Nonextended resections (n = 32)*		
	n	*%*	*n*	*%*	*p Value*
Complication by type					
Arrhythmia	22	23	4	13	NS
Myocardial infarction	2	2	0	0	NS
Congestive heart failure	2	2	0	0	NS
Secretory retention/atelectasis	15	16	1	3	NS
Respiratory insufficiency*	11	12	3	9	NS
Postoperative hemorrhage (>3 units)	12	13	1	3	NS
Pneumonia	8	9	0	0	NS
Pleural empyema	2	2	1	3	NS
Bronchial stump insufficiency	5	5	1	3	NS
Wound infection	4	4	3	9	NS
Sepsis	2	2	0	0	NS
Recurrent nerve lesion	5	5	3	9	NS
Others (e.g., pericardial effusion)	11	12	0	0	NS
Total	67	71	9	28	<0.002
Patients with multiple complications					
1 Complication	38	40.4	4	12.5	0.007
2 Complications	21	22.3	4	12.5	NS
3 Complications	6	6.4	0	0	NS
4 Complications or more	2	2.1	1	3.1	NS
Multiple total	29	30.8	5	15.6	NS

*Defined as postoperative $P_{O_2} < 60$ mm Hg breathing ambient air.

tiorgan failure, one patient died of postoperative hemorrhage, two patients died of postpneumonectomy adult respiratory distress syndrome, and two patients died of pneumonia. Two (6.3%) out of 32 patients died after nonextended resections, both of respiratory failure. This difference was not statistically significant. All patients who died had undergone pneumonectomies. In the group of patients who underwent extended resection no difference was found in the 30-day mortality rate between the subgroups with a T3 tumor (n = 5, 7.8%) or T4 tumor (n = 2, 6.7%).

Postoperative complications (Table V). The postoperative course was uneventful in 27 (29%) patients, whereas 67 (71%) patients had complications after extended resections. Nine (28%) patients had complications after nonextended resections ($p < 0.002$ versus extended resections). In the group of patients who underwent extended resection no significant difference was found in the morbidity between the subgroups with a T3 tumor (n = 43, 67%) or T4 tumor (n = 24, 80%) (p = 0.059). Atelectasis was considered a major complication if it necessitated more than one bronchoscopy procedure to reexpand the lobe or lung affected.

Risk analysis

Correlation of risks and complications. Correlation of risk factors and postoperative complications in patients undergoing extended resections is shown in Tables VI and VII. Analysis of postoperative deaths showed that the risk of dying after an extended operation did not correlate with a history of respiratory disease, metabolic disease, chronic alcohol abuse, history of cardiac disease, pulmonary function test results, or results of bicycle ergonometry. Moreover, the pulmonary or cardiac risk score did not enable prediction of the lethal outcome of an operation. Twenty-five percent of the patients in whom pneumonia developed died of this complication and 18% of those in whom respiratory insufficiency developed died. One of two patients who had an acute myocardial infarction died, whereas all patients who had arrhythmia or congestive heart failure survived. Patients older than 70 years tended to have a lower mortality and morbidity rate (0% and 58.3%, respectively) than younger patients (10% and 75.7%, respectively) (not significant). The type of surgical procedure done correlated with the mortality, with all postoperative deaths occurring in the group that underwent pneumonectomy.

Cardiac complications. The development of postoperative tachyarrhythmias correlated with a history of coronary artery disease, pathologic ergonometry, and a high risk in the cardiac risk score (Tables VI and VII). Sixteen percent of the patients in the low cardiac risk group had cardiac complications com-

Table VI. *Risk analysis in patients undergoing extended resections (cardiovascular complications)*

Risk factors	Complications (n)	Myocardial infarction (n = 2)	Arrhythmias (n = 22)	Congestive heart failure (n = 2)	Postoperative hemorrhage (n = 12)
Pathologic ergonometry	19		12 ($p < 0.002$)		4
Myocardial infarction	2		1		
Hypertension*	32	2	11	1	5
Myocardial insufficiency	5	1		1	2
Coronary artery disease	12	1	6 ($p = 0.049$)	1	2
Cardiac score	25	1	12 ($p < 0.003$)	1	5
Age ≥70 yr	24	1	6	1	4

The numbers in columns reflect the number of patients with each risk factor in whom the mentioned complication developed. Many patients in whom complications developed had several risk factors. No significant association was found between cardiovascular complications and emphysema, COPD, pneumonia, cardiac history, arrhythmias, alcohol abuse, renal insufficiency, diabetes mellitus, elevated liver function test results, arterial Po_2, Po_2 increase under stress, pulmonary risk score I and II, FEV_1, VC_{rel}, FEV_{1rel}/VC_{rel}, or FEV_{1rel}. VC_{rel}, Relative vital capacity; FEV_{1rel}, relative FEV_1.

*Defined as diastolic pressure ≥90 mm Hg.

Table VII. *Risk analysis in patients undergoing extended resections (respiratory complications)*

Risk Factors	Complications (n)	Pneumonia (n = 8)	Respiratory insufficiency (n = 11)	Atelectasis/ secretory retention (n = 15)	Seropneumothorax (n = 15)	Total (n = 67)
Emphysema	12		1	1	5 ($p = 0.055$)	8
Pneumonia	8		1	1		4
COPD	60	6	8	14 ($p = 0.21$)	9	47
Pulmonary risk score I						
Intermediate risk	40	2	4	9 ($p = 0.047$)	8	28
High risk	13	1	4	4 ($p = 0.037$)	4	12
Pulmonary risk score II						
Intermediate risk	54	6	7	11 ($p = 0.054$)	9	41
High risk	18	2	2	4	4	14
FEV_1*						
Intermediate risk	21	1	2	6	1	18
High risk	7		2	1	4	6
VC_{rel}*						
Intermediate risk	20	2		7	4	14
High risk	6		2			6
FEV_{1rel}/VC_{rel}†	56	5	6	9	11	39
FEV_{1rel}						
40%-50%	5		1			4
<40%	0					
Age ≥70 yr	24	1		4	4	14

The numbers in columns reflect the number of patients with each risk factor in whom the mentioned complication developed. Many patients in whom complications developed had several risk factors. No significant association was found between respiratory complications and cardiac history, coronary artery disease, cardiac score, pathologic ergonometry, myocardial infarction, hypertension, cardiac history, myocardial insufficiency, arrhythmias, alcohol abuse, renal insufficiency, diabetes mellitus, elevated liver function test results, arterial Po_2, or Po_2 increase under stress. VC_{rel}, Relative vital capacity; FEV_{1rel}, relative FEV_1.

*As defined for the pulmonary risk score II.

†A ratio operation 0.7 was considered to indicate an increased risk.

pared with 56% in the high cardiac risk group ($p = 0.011$).

Respiratory complications. The development of bronchial secretory retention or atelectasis was significantly correlated with a moderate or high pulmonary risk score I and a history of COPD but not with pulmonary risk score II (Tables VI and VII). Of the respiratory parameters only FEV_1 tended to be lower in patients in whom bronchial secretory retentions developed (mean value 2.03 L versus 2.37 L) ($p = 0.069$). In contrast development of pneumonia was not significantly correlated with the pulmonary risk scores or a history of metabolic disease.

All other cardiac, pulmonary, or metabolic risk factors bore no relation to the development of postoperative complications.

Survival. Analysis of survival showed a significantly superior 3-year survival of 58% for nonextended resections over extended resections with a

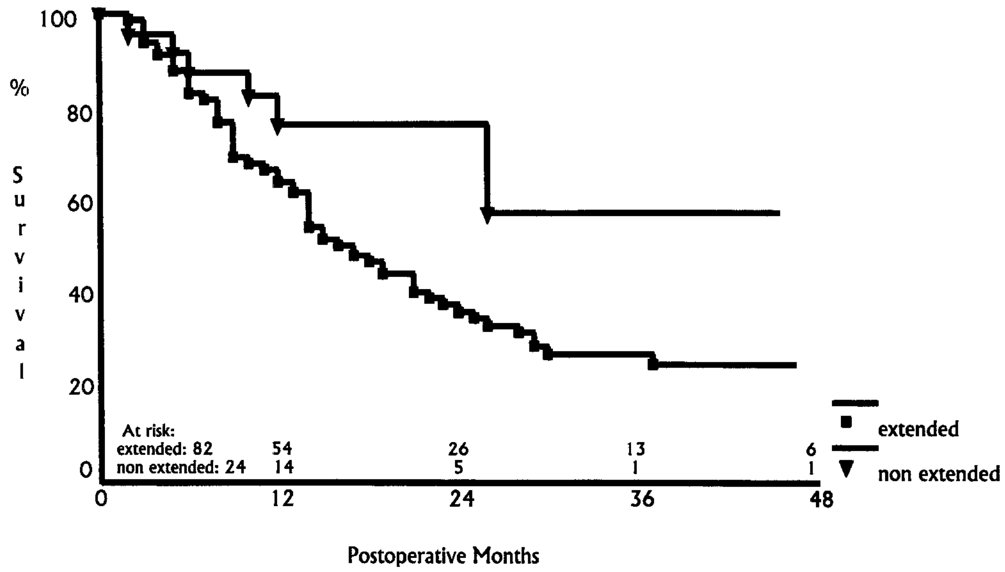

Fig. 1. Survival curves according to surgical procedure. *$p < 0.05$ versus extended resections.

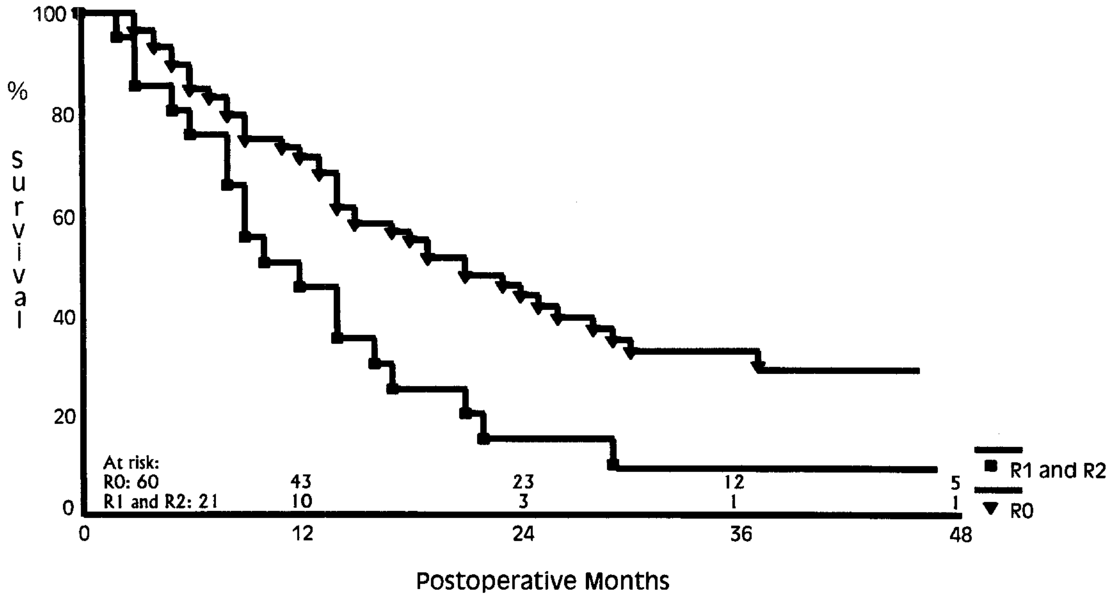

Fig. 2. Survival curves after extended resections according to resection margins. *$p < 0.05$ versus R0 resections.

3-year survival of 27% (p = 0.04) (Fig. 1). This was no longer statistically significant when only patients having R0 resection were considered (p = 0.15). Patients with R0 resected tumors fared significantly better than patients with R1 or R2 resected tumors, as expected (Fig. 2) (p = 0.02). Three-year survival was 33% in the R0 group versus 10% in the R1/R2 group. Patients with R1 resections had no better survival than patients with R2 resections (p = 0.14). In contrast, no significant difference was observed between T3 and T4 tumors (Fig. 3). Although lymph node staging seemed to influence survival, this difference did not reach statistical significance (Fig. 4). Pathologic proof of tumor invasion into adjacent organs was associated with a worse prognosis. In these patients the 3-year survival was 21% versus a 3-year survival of 36% in patients with inflam-

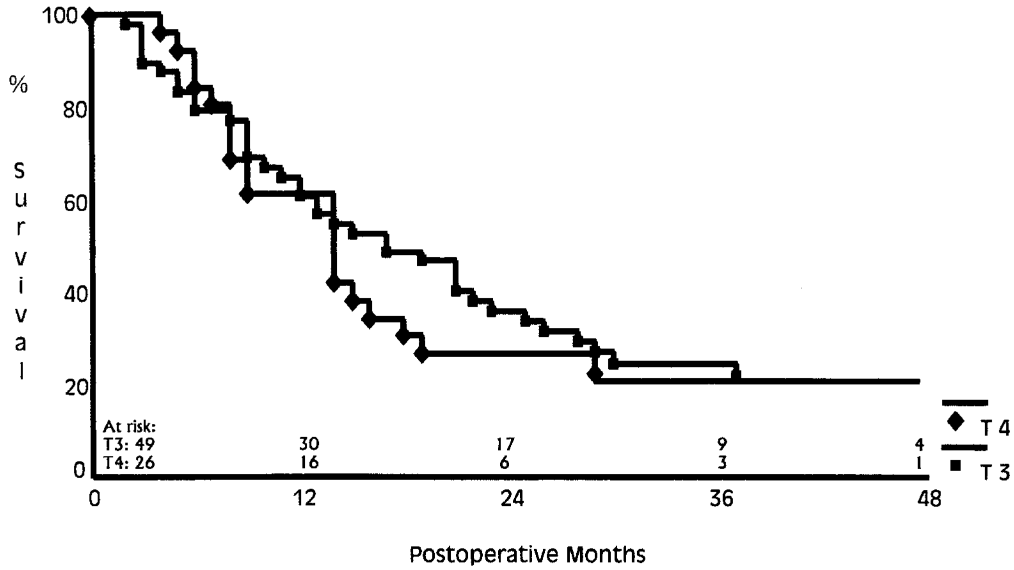

Fig. 3. Survival curves after extended resections according to T stage.

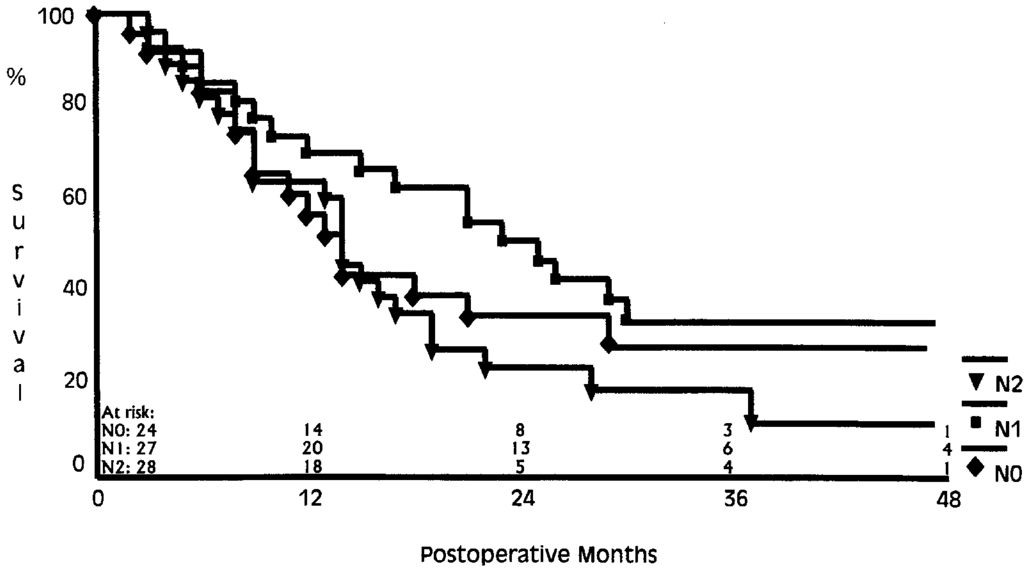

Fig. 4. Survival curves after extended resections according to N stage.

matory adherence (p = 0.035). The type of organ infiltrated did not influence survival.

The extent of pulmonary resection had no influence on survival among the patients who underwent extended resection. After extended pneumonectomy 3-year survival was 29.7% and after extended lobectomy 3-year survival was 32.6%.

Discussion

This study was designed to evaluate the merit of extended resections for locally advanced lung cancer. Twenty-nine percent of our patients with lung cancer who underwent resection had an extended procedure. We attribute this high percentage to two facts. First, we think that macroscopic adherence of a tumor to an adjacent structure demands an extended resection. We do not try to verify tumor invasion by frozen section because of the risk of tumor dissemination.[7] Second, in view of the natural history of locally advanced lung cancer with a 1-year survival of 5%[1,8] we pursue a rather aggressive approach. Preoperative suspicion of invasion of mediastinal organs is not considered a contraindication for exploratory operation at our institution. This seems to be justified by the 3-year survival rates presented herein.

The postoperative mortality rate for extended resections was 7.4% and for nonextended resections was 6.3%. This is well within the range of the expected mortality.[9-15] In our own experience in a series of 145 consecutive patients undergoing nonextended resection for T1 or T2 lung cancers the 30-day mortality rate was 4.1% (not significant versus extended resections). Although the difference in postoperative mortality between extended and nonextended resections was not statistically significant the difference in postoperative morbidity was. Postoperative morbidity tended to be somewhat elevated after resection for T4 lung cancers although this difference did not reach statistical significance. This increased risk concerned cardiopulmonary complications only, which account for the majority of principal complications after pulmonary resections.[16-19] The high risk of the development of one of these complications will influence the indication for operation in many institutions because most extended resections are planned as extended resections after preoperative staging by radiologic means.[5] It is therefore of particular interest to determine the risk factors that predispose for these complications and to analyze the outcome. The aim of this risk factor analysis was to either exclude certain patients from operation or to find particular precautions that could prevent complications.

Risk factors that predisposed to complications were history of coronary artery disease, pathologic ergonometry, high risk in the cardiac risk score, COPD, and an elevated pulmonary risk score I. None of these risk factors predisposed to a lethal outcome so as to justify exclusion of a patient from operation. This may be a result, in part, of the rare occurrence of myocardial infarction and congestive heart failure. Of the 25 patients with an elevated cardiac score only 1 patient each had the development of myocardial infarction or congestive heart failure. Complications that arose were usually managed conservatively with satisfactory success. The described extensive routine preoperative work-up should suffice to offer these patients the best diagnostic and therapeutic management of their disease. A coronary angiogram should be reserved for patients with pertinent coronary history and symptoms. We stress, however, that this extensive preoperative work-up and intensive postoperative surveillance is imperative in all patients undergoing resection for lung cancer.

All patients who died in this study had undergone pneumonectomy. Nevertheless the aim to achieve R0 resections is of paramount importance considering the poor outcome if locally advanced lung cancer is not resected. Because a 30% 3-year survival can be achieved after extended resections even a 17% mortality rate in the pneumonectomy group should not deter the surgeon from potentially curative resection.

In contrast to other studies,[10, 20, 21] we cannot propose a less aggressive approach in elderly patients. In accordance with results of a recent report[22] age neither predisposed the patient to a lethal outcome nor to complications despite a comparative spectrum of procedures done in the high percentage of elderly patients (Tables VI and VII).

Three-year survivals of 27% after extended resections and 3-year survivals after all resections for T3 and T4 tumors of 25% and 22%, respectively, are well within the range of what is reported in the literature.[9, 13, 23-25] Although at this point we cannot give 5-year survival rates, it is of interest that as in this study survival curves tend to reach a plateau after 2 years.[9]

No significant differences were observed between results in T3 and T4 stage cancers. In accordance with other reports[26] the differences seen between N0/N1 and N2 stages also did not reach statistical significance. This may be because of the limited number of patients in this study and could eventually become significant with a longer follow-up. We presume, however, that this finding emphasizes the prognostic importance of locally advanced tumors. Larger series of patients will have to be evaluated to permit a definitive conclusion. With surgical resection still offering the best hope for cure in lung cancer[27-31] and neoadjuvant therapy and radiation therapy still being evaluated,[32-34] the key to improving treatment remains trying to resect without residual tumor.

We therefore trust that even elderly patients or patients with severe cardiopulmonary risk factors should not be excluded from the benefits of possibly curative operation. Postoperative mortality cannot be reduced by excluding on the basis of particular risk factors patients from operation who require extended resections. If a patient is considered to be eligible to undergo pulmonary resection, he or she can be considered to be eligible to undergo extended pulmonary resection. However, improvement of preoperative and postoperative cardiopulmonary care will increase the safety with which these procedures can be done.

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